

Semester and Year: **Fall 2020 (July 30, 2020)**

Stony Brook University
Department of Physics and Astronomy
College of Arts and Sciences

PHY 153 “Data Analysis for Physics and Astronomy with Python

This course satisfies the DEC category N/A

This course satisfies the SBC category TECH

Course Instructor: Prof. Joanna Kiryluk

Contact: Joanna.Kiryluk@stonybrook.edu

Section: 01

Class Format: In Person

Instructor contact information Joanna.Kiryluk@stonybrook.edu.

COURSE DESCRIPTION:

Must match the *Bulletin* exactly.

<http://www.stonybrook.edu/ugrdbulletin/current/index.shtml>

If the course is a “topics course” see below.

This course is an introduction to statistical data analysis with modern techniques, including the Python programming language on Windows computers. It consists of two parts. Part A will review concepts and methods to characterize experimental data such as averages, variances, standard deviations, errors and error propagation, covariances and correlations. It will discuss the binomial, Poisson and Gaussian distributions, probabilities, confidence intervals, limits, hypothesis testing, chi2 minimization and straight line fitting, and will focus on their practical applications in experimental data analysis. Part B will introduce students with no prior experience in computing programming to the Python language, with emphasis on data-centric applications. This course will include plentiful practical examples and will require extensive use of computers outside the classroom. The aim of this hands-on course is to prepare Physics and Astronomy majors for experimental laboratory work.

Credits: 3

SBC: TECH

Course Topic

If a course is a topics course, indicate the specific topic description here.

Part a: Introduction to Data Analysis

1. Introduction: what is a measurement, random and systematic uncertainties
2. Data characteristics: distribution, mean and variance
3. Graphic representation of data: histograms, plots, linear and logarithmic scales
4. Statistics: binomial, Poisson and Gaussian probability distributions
5. Central Limit Theorem
6. The meaning of sigma
7. Partial differentiation, propagation of small uncertainties
8. Covariance and correlation
9. Least squares method
10. Combining results of different experiments, weighted averages
11. Straight line fit

Part a: Introduction to Python

1. Python from scratch:
 - a. IPython: An Interactive Computing and Development Environment
 - b. Variables, basic math, types of data, input, print formatting and strings
 - c. Decisions, loops, lists, functions, objects, modules
 - d. Data files: input and output, file formats
 - e. Data wrangling: Clean, transform, merge, reshape
 - f. Plotting and Visualization
2. Data analysis modules
 - a. NumPy Basics
 - b. SciPy Basics
3. Data analysis report

- a. Latex

Course Pre/co-requisites

Indicate the approved course prerequisites (as published: <http://www.stonybrook.edu/ugrdbulletin/current/index.shtml>)

PHY 133 and a grade of C or better in:
either MAT 125 or MAT 131 or MAT 141 or AMS 151 or MAT 171

COURSE LEARNING OBJECTIVES:

Include course objectives. If this course is approved to satisfy D.E.C. and/or the SBC, the objectives **must** address how the course outcomes relate to the specified D.E.C or SBC category. See the DEC descriptions in the Bulletin. Include a brief description of the opportunities this course would provide for students to acquire the knowledge or skills necessary to achieve the course learning outcome(s)

The students learning objective is to understand technology by gaining a hands-on experience in data analysis with modern computer-based tools, such as the Python programming language, with the goal to prepare Physics and Astronomy majors for experimental laboratory work. Students will become proficient at working with data in Python by learning the fundamentals of the language to write computer programs to solve data analysis problems. Specifically they will learn to solve data analysis problems using quantitative statistical methods and will learn how to obtain, and present results quantitatively and graphically. This hands-on course is ideal for starting Physics and Astronomy majors new to Python.

COURSE REQUIREMENTS:

Attendance and Make Up Policy: Attendance will be taken but is not required.

Policy for late work: You may request a deadline extension.

Description and schedule of Required Readings and/or Assignments.

Include bibliographical list of readings, library reserve items, etc.

Mandatory Course Material:

1. **Zybooks/ZyLab: “PHY153: Data Analysis for Physics and Astronomy with Python” [!!! subscription required !!!]**
zybooks.com: a digital courseware platform for computer science and STEM courses

Subscription Instructions:

- Sign in or create an account at **learn.zybooks.com**
- Enter zyBook code
- **Subscribe**

2. Textbook: “An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, John R. Taylor

Recommended Textbooks:

1. “A Practical Guide to Data Analysis for Physical Science students”, Louise Lyons
2. “Introduction to Programming Using Python”, Y. Daniel Liang

Software requirements (laptops or personal computers):

anaconda3 package (python3 with additional modules needed for this course)

Requirements for written assignments:

Must be submitted electronically as will be stated in homework assignments.

Include a brief description of the graded assignments that the instructor(s) will use to evaluate the students' achievement of the outcome(s) :

Exams

Number and Description of Exams (include dates in meeting schedule section below).

There will be weekly quizzes.

There will be one (final) take home project. Students will analyze a data set provided to them by using data analysis techniques, writing a Python computing program and writing a report.

GRADING:

Describe the components of the course, and indicate how each component of the course will be factored into the final course grade; often expressed in %

Indicate alphanumeric breakdown of grades or explicit description of the grading technique (i.e., description of the "curve," or A= 95-100, A- = 90-95, or whatever the instructor defines)

Final grades will be determined by weighting the various portions of the course as follows:

- o **70% zybooks / homework assignments, quizzes**
- o **30% final "take home project": analyze lab data sample and write a report.**

Grades:

- o Weighted average: 95 % - 100 % grade A
- o Weighted average: 90 % - 94.99 % grade A-
- o Weighted average: 85 % - 89.99 % grade B+
- o Weighted average: 80 % - 84.99 % grade B
- o Weighted average: 70 % - 79.99 % grade B-
- o Weighted average: 60 % - 69.99% grade C+
- o Weighted average: 50 % - 59.99 % grade C
- o Weighted average: 45 % - 49.99 % grade C-
- o Weighted average: 40% - 44.99 % grade D+
- o Weighted average: 35 % - 39.99 % grade D
- o Weighted average < 35% grade F

P/NC: If you decide to take the course for **PASS/NO CREDIT**, you must change before the University-imposed deadline. All grades will be accessible via the blackboard for this course.

MEETING SCHEDULE

List each class meeting and assignments and topics for each. Include Exam Schedule and assignment due dates

The class will meet two times a week: TU, THU 11.30-12.50PM Eastern Time (US and Canada)

Office hours: will be announced at a later time

CLASS RESOURCES (examples below)

Library resources

Blackboard

Writing Center

Career Center

Others (see link) <http://stonybrook.edu/aadvising/tut.html>

The University Senate Undergraduate and Graduate Councils have authorized that the following required statements appear in all teaching syllabi (graduate and undergraduate courses) on the Stony Brook Campus. See also <http://www.stonybrook.edu/provost/facultyinfo/Syllabus%20Statement.doc>

STUDENT ACCESSIBILITY SUPPORT CENTER STATEMENT (must be the following language)

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

<https://www.stonybrook.edu/commcms/studentaffairs/sasc/facstaff/syllabus.php>

[In addition, this statement on emergency evacuation is often included, but not required:

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support

Services. For procedures and information go to the following website: <https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-people-physical-disabilities>]

ACADEMIC INTEGRITY STATEMENT (must be the following language as approved by the undergrad council):

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

CRITICAL INCIDENT MANAGEMENT (must be the following language as approved by the undergrad council): Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.